US011584102B2

(12) **United States Patent**
Orsini et al.

(10) **Patent No.: US 11,584,102 B2**
(45) **Date of Patent: Feb. 21, 2023**

(54) **FILL MATERIAL CUTTING MECHANISMS AND METHODS**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **17/275,571**

(22) PCT Filed: **Sep. 12, 2019**

(86) PCT No.: **PCT/US2019/050772**
§ 371 (c)(1),
(2) Date: **Mar. 11, 2021**

(87) PCT Pub. No.: **WO2020/056106**
PCT Pub. Date: **Mar. 19, 2020**

(65) **Prior Publication Data**

US 2022/0048270 A1 Feb. 17, 2022

Related U.S. Application Data

(60) Provisional application No. 62/731,125, filed on Sep. 14, 2018.

(51) **Int. Cl.**
B31D 5/00 (2017.01)

(52) **U.S. Cl.**
CPC ***B31D 5/0039*** (2013.01); *B31D 2205/007* (2013.01); *B31D 2205/0052* (2013.01); *B31D 2205/0058* (2013.01)

(58) **Field of Classification Search**
CPC B31D 5/0039; B31D 2205/0052; B31D 2205/0058; B31D 2205/007
See application file for complete search history.

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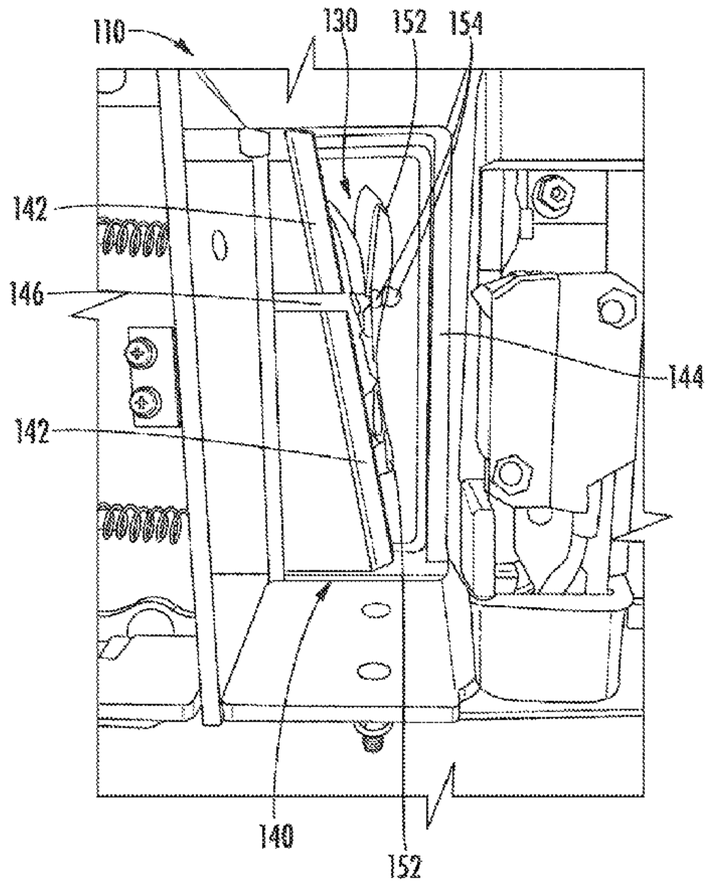
(57) **ABSTRACT**

A system includes a source of sheet material and a conversion machine. The conversion machine is configured to receive the sheet material and to form the sheet material into a fill material. The conversion machine further includes a cutting mechanism configured to cut the fill material. The cutting mechanism is configured such that, when cutting the fill material to form two pieces of fill material, uncut portions of the fill material remain between the two pieces of fill material.

16 Claims, 6 Drawing Sheets



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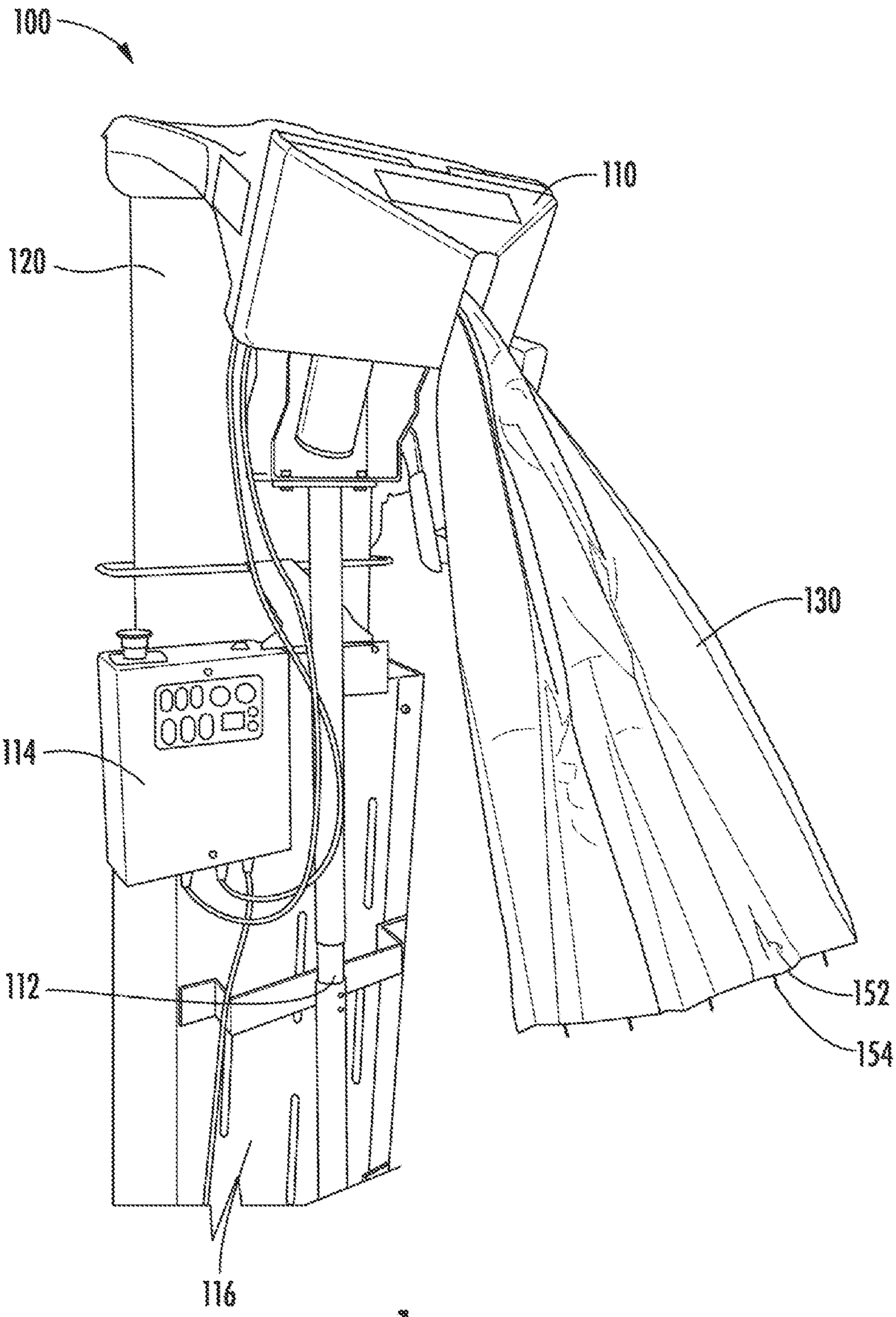

FIG. 1

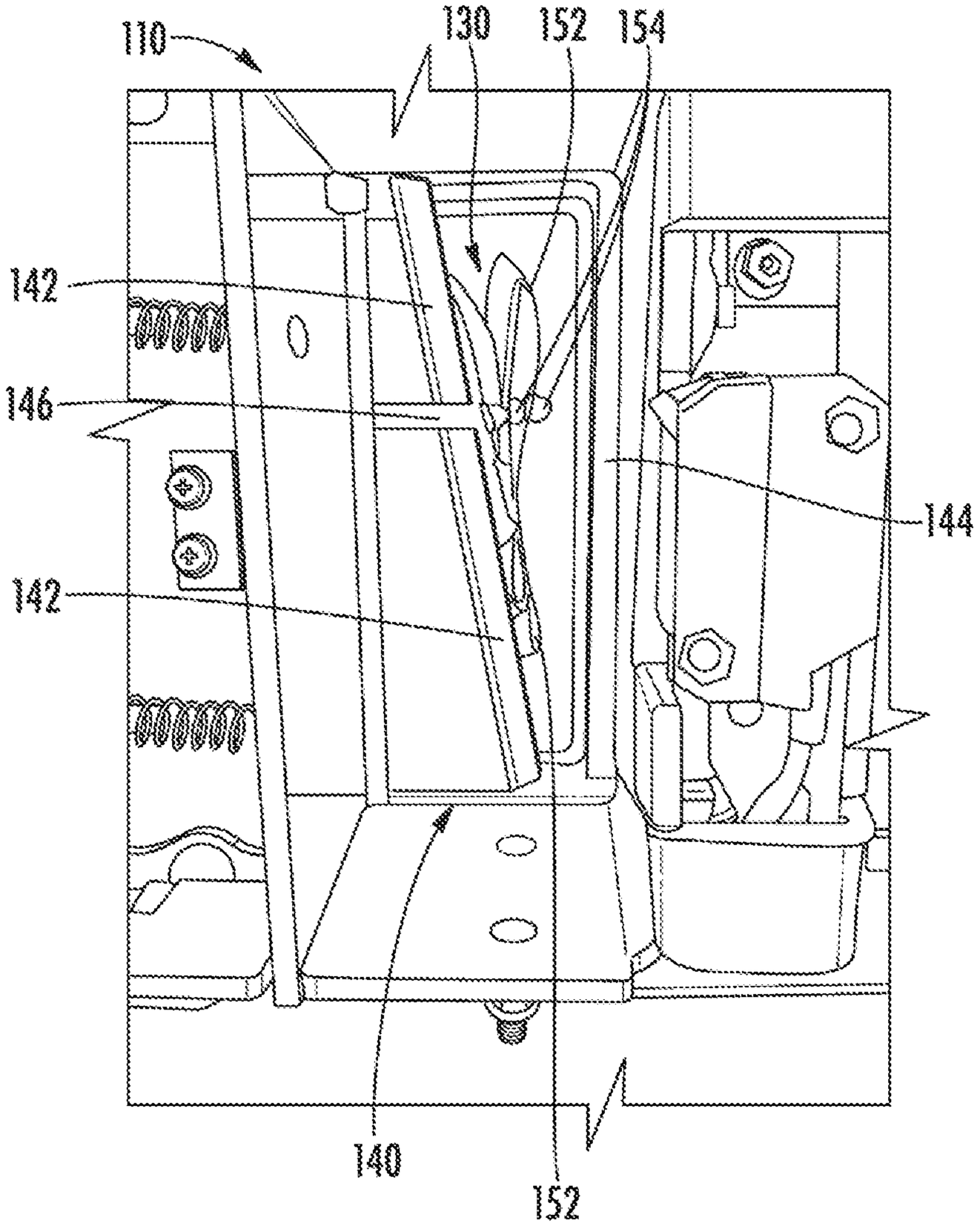

FIG. 2

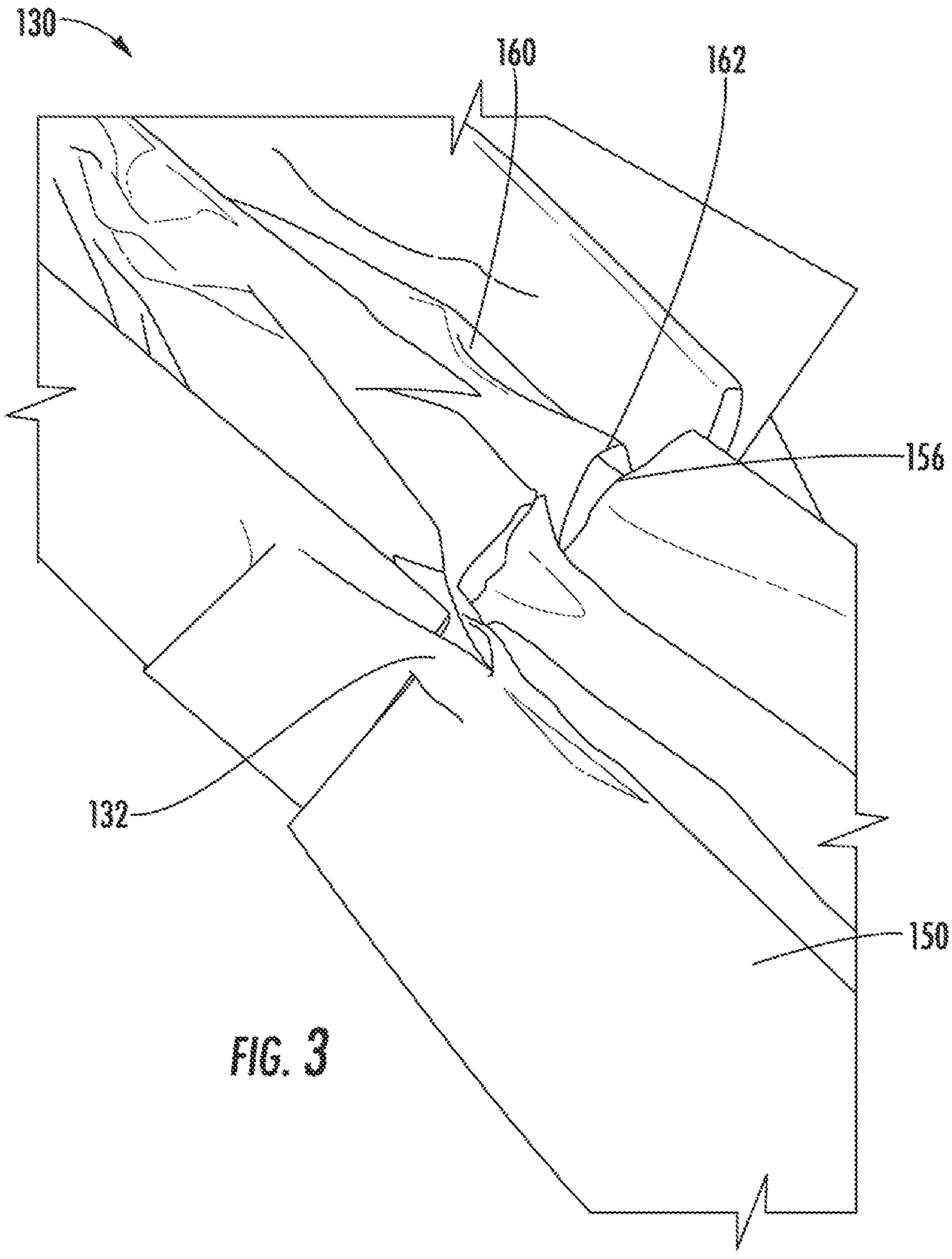

FIG. 3

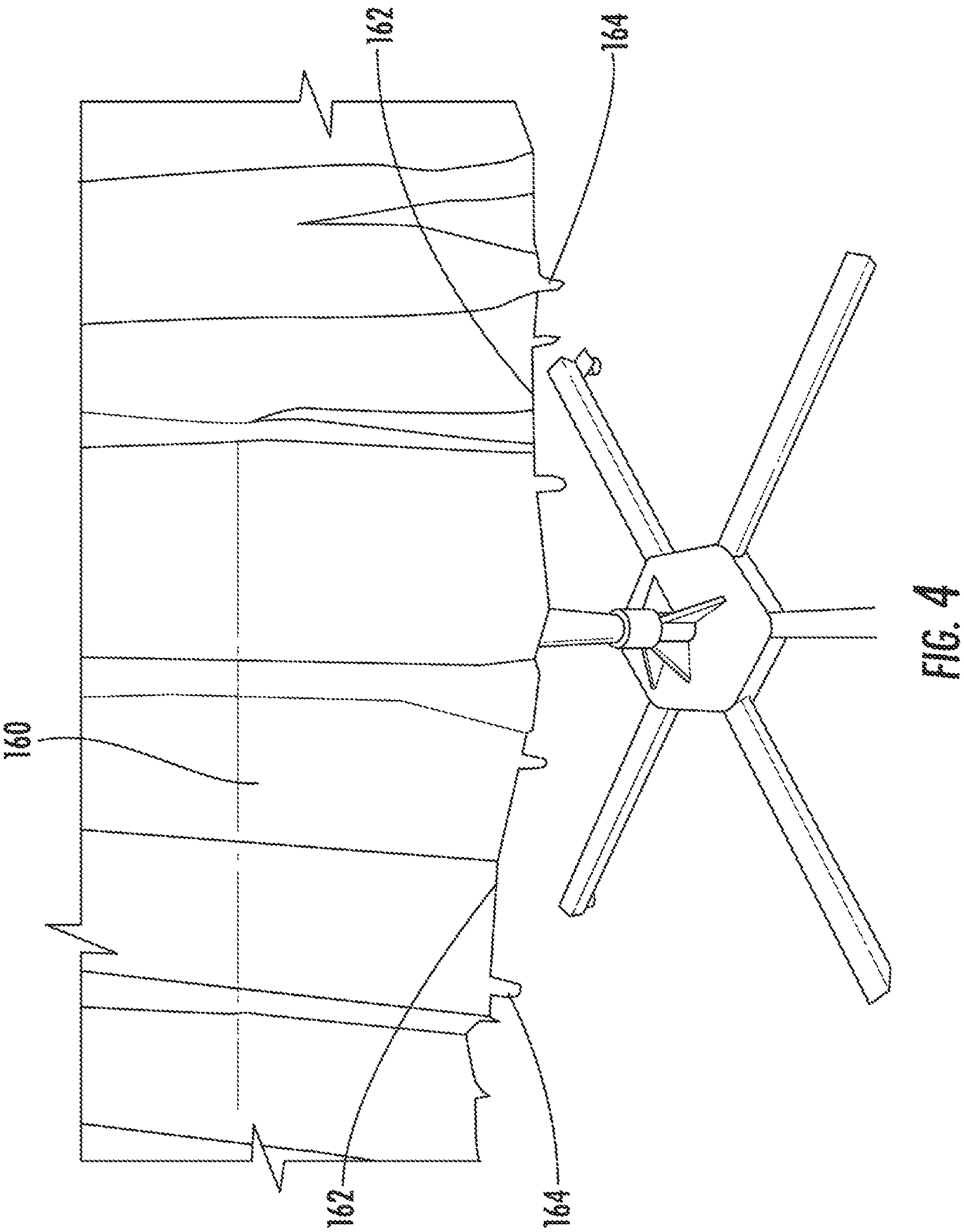

FIG. 4

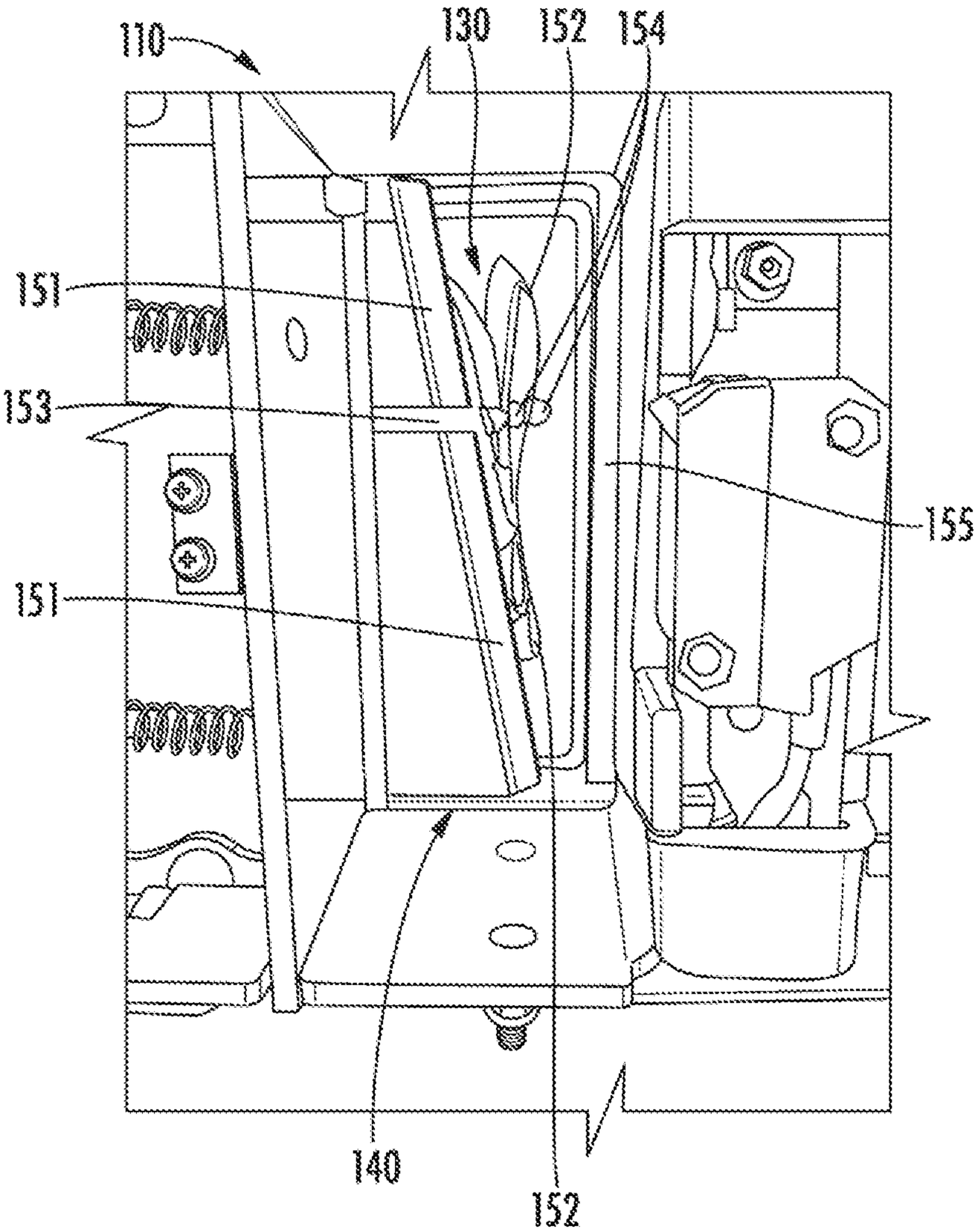

FIG. 5

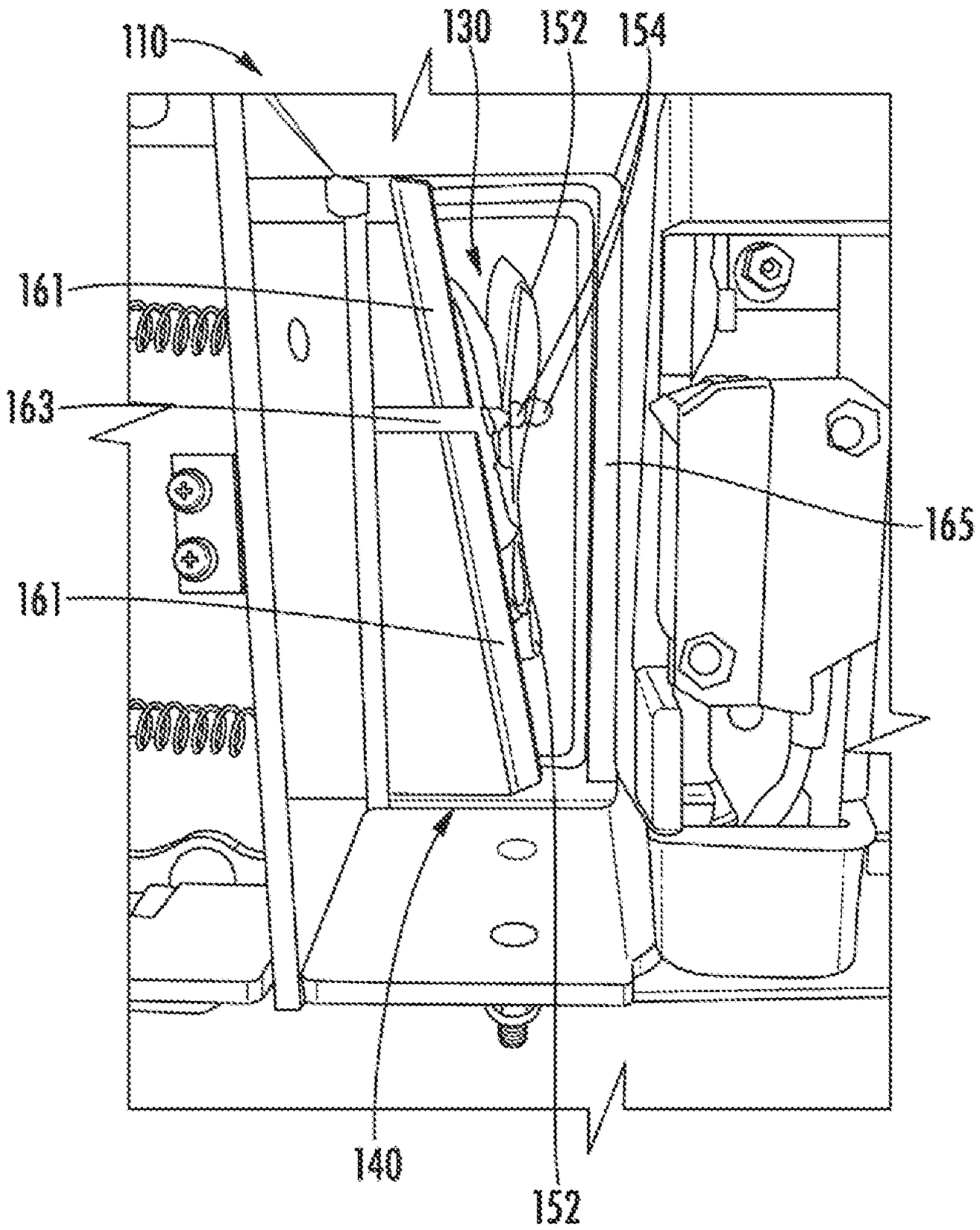

FIG. 6

FILL MATERIAL CUTTING MECHANISMS AND METHODS

BACKGROUND

The present disclosure is in the technical field of dunnage or packaging materials. More particularly, the present disclosure is directed to method for producing package fill material from sheets of a selected substrate, such as paper.

Conversion machines for producing fill material from paper are well-known. Such conversion machines generally operate by pulling a web of paper from a roll or fanfold paper, manipulating the paper web in such a way as to convert the paper into fill material, and then severing the converted material into cut sections of a desired length. Conversion machines may be void fill conversion machines that form sheet material into fill material that can be used as void fill, cushion conversion machines that form sheet material into fill material that can be used as cushioning, or any other similar conversion machine. While such conversion machines are widely used and have been commercially successful in many applications, there is a need for improved functionality and decreased cost of some of the components of such conversion machines.

SUMMARY

This summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This summary is not intended to identify key features of the claimed subject matter, nor is it intended to be used as an aid in determining the scope of the claimed subject matter.

In a first embodiment, a system includes a source of sheet material and a conversion machine. The conversion machine is configured to receive the sheet material and to form the sheet material into a fill material. The conversion machine further includes a cutting mechanism configured to cut the fill material. The cutting mechanism is configured such that, when cutting the fill material to form two pieces of fill material, uncut portions of the fill material remain between the two pieces of fill material.

In a second embodiment, the previous embodiment is configured such that the uncut portions are arranged such that, when one of the two pieces of the fill material is pulled away from each other, the uncut portions tear, resulting in the two pieces of the fill material being separated from each other.

In a third embodiment, any of the previous embodiments is arranged such that a percentage of a width of the fill material that remains connected by the uncut portions is in a range between about 1% and about 10%.

In a fourth embodiment, any of the previous embodiments is arranged such that a width of the fill material that remains connected by the uncut portions is in a range between about 3% and about 9%.

In a fifth embodiment, any of the previous embodiments is arranged such that a percentage of a width of the fill material that remains connected by the uncut portions is in a range between about 5% and about 8%.

In a sixth embodiment, any of the previous embodiments is arranged such that a percentage of a width of the fill material that remains connected by each of the uncut portions is less than or equal to any one of 1%, 0.8%, 0.6%, 0.4%, or 0.2%.

In a seventh embodiment, any of the previous embodiments is arranged such that the cutting mechanism includes a first cutting surface and a second cutting surface, and at least one of the first and second cutting surfaces is configured to move with respect to the other of the first and second cutting surfaces to cut portions of the fill material.

In an eighth embodiment, the seventh embodiment is configured such that the first cutting surface is a notched blade that includes a notch.

In a ninth embodiment, the eighth embodiment is configured such that a length of the notch is a percentage of a length of the first cutting surface that is less than or equal to or any one of 10%, 9%, 8%, 7%, 6%, 5%, 4%, 3%, 2%, or 1%.

In a tenth embodiment, any of the seventh through ninth embodiments is configured such that the fill conversion machine is configured to fold or crumple the sheet material to form the fill material.

In an eleventh embodiment, the tenth embodiment is configured such that, after the sheet material is folded or crumpled to form the fill material, multiple plies of the fill material are arranged to be cut by the cutting mechanism.

In a twelfth embodiment, any of the previous embodiments is arranged such that the cutting mechanism includes a single cutting surface that includes a notch.

In a thirteenth embodiment, the twelfth embodiment is configured such that the single cutting surface is configured to move into a slot as the single cutting surface cuts the fill material.

In a fourteenth embodiment, any of the previous embodiments is arranged such that the cutting mechanism includes at least two separate cutting surfaces that are separated by a gap and the uncut portions of the fill material are aligned with the gap as the cutting mechanism cuts the fill material.

In a fifteenth embodiment, the fourteenth embodiment is configured such that the at least two separate cutting surfaces is configured to move into a slot as the at least two separate cutting surfaces cut the fill material.

In a fifteenth embodiment, any of the fourteenth or fifteenth embodiments is configured such that the gap has a length that is in a range between about 0.1 inches and about 0.15 inches.

In a seventeenth embodiment, a method includes converting, by a fill conversion machine, a sheet material into a fill material and cutting, by a cutting mechanism of the fill conversion machine, the fill material to form two pieces of fill material. The cutting includes leaving uncut portions of the fill material between the two pieces of fill material. The two pieces of fill material include a first piece and a second piece. The method further includes holding, by the conversion machine, a second piece of the two pieces of fill material. The first piece is separable from the second piece during the holding by pulling the first piece from the second piece to cause the uncut portions of the fill material to tear.

In an eighteenth embodiment, the method of the seventeenth embodiment further includes detecting, by the conversion machine, that the first piece has been pulled away from the second piece.

In a nineteenth embodiment, the method of the eighteenth embodiment further includes, in response to the detecting, automatically advancing, by the conversion machine, the fill material out of the fill conversion machine and in response to the detecting, automatically cutting, by the cutting mechanism of the conversion machine, the fill material to form a cut between the second piece and a third piece of the fill material such that uncut portions of the fill material remain between the second and third pieces of fill material.

In a twentieth embodiment, the method of the nineteenth embodiment further includes holding, by the conversion

machine, the third piece of fill material. The second piece is separable from the third piece during the holding of the third piece by pulling the second piece from the third piece to cause the uncut portions of the fill material between the second and third pieces to tear.

BRIEF DESCRIPTION OF THE DRAWING

The foregoing aspects and many of the attendant advantages of the disclosed subject matter will become more readily appreciated as the same become better understood by reference to the following detailed description, when taken in conjunction with the accompanying drawings, wherein:

FIG. **1** depicts an embodiment of a conversion machine for producing fill material, a source of sheet material, and an embodiment of fill material cutting using one of the embodiments of cutting mechanisms described herein;

FIG. **2** depicts an embodiment of a cutting mechanism capable of cutting converted sheet material in accordance with the cutting methods described herein;

FIG. **3** depicts an embodiment of two pieces of cut fill material before the two pieces of cut fill material have been separated, in accordance with the embodiments described herein;

FIG. **4** depicts an embodiment of one of the two pieces of cut fill material shown in FIG. **3** after the two pieces of cut fill material have been separated, in accordance with the embodiments described herein;

FIG. **5** depicts an embodiment of a cutting mechanism capable of cutting converted sheet material in accordance with the cutting methods described herein; and

FIG. **6** depicts an embodiment of a cutting mechanism capable of cutting converted sheet material in accordance with the cutting methods described herein.

DETAILED DESCRIPTION

Referring to FIG. **1**, a system **100** is depicted that includes a conversion machine **110** for producing fill material **130** from a sheet material **120** of a selected substrate. In FIG. **1**, the conversion machine **110** is depicted being supported by a support stand **112** that is configured to stand on the floor. Other configurations of the conversion machine **110** are possible, such as a tabletop configuration of the conversion machine **110**. In the depicted configuration, the conversion machine **110** the support stand may be height adjustable or otherwise configurable us a user. Other related components, such as a control unit **114**, a sheet supply bin **116**, and a support base (not visible) may also be connected to the stand **112**. The control unit **114** may include a user interface or other user operable switches, buttons, dials or other controls to manage operation of the conversion machine **110**. For example, the control unit **114** may include an emergency stop button or other controls that allow an operator to adjust modes of operation or to select a particular length of fill material to dispense. The sheet supply bin **116** is sized and shaped to accommodate different sheet sizes and densities. In one embodiment, the size of the supply bin **116** may be adjustable to accommodate different sheet supply widths, for example 15" or 30" wide fanfold stock. In another embodiment, a sheet of fill material can be supplied to the conversion machine **110** in the form of a roll of stock sheet material. Thus, a horizontal bar (not shown) might be secured nearby or directly to the stand **112** to support such a roll of stock sheet material. In one embodiment, the sheet supply bin **116** might be positioned near, but not directly coupled to the conversion machine **110**. In some embodiments, a support base secured to the stand **112** to a stable platform such as legs, casters, a table, or any other mounting location (e.g., a work bench or a product conveyor). The support base may be secured to a fixed or mobile platform as appropriate depending on the requirements of a particular packaging environment.

The conversion machine **110** is configured to receive a sheet material **120** and to convert the sheet material **120** into fill material **130**. The fill material **130** has a configuration that is different from the sheet material. In some embodiments, the conversion machine **110** is configured to crush, crumple, fold, or otherwise deform the sheet material **120** from its sheet orientation into the non-sheet orientation of the fill material **130**. The conversion machine **110** may include crush wheels, gears, deforming cylinders, folding bars, folding plates, pulleys, or other deforming components that are in the path of the sheet material **120** to cause the sheet material **120** to be converted from its sheet orientation (substantially a two-dimensional form) to the non-sheet orientation of the void fill material **130** (substantially a three-dimensional form). Examples of such

Most conversion machines include a severing mechanism to periodically sever the converted fill material into pieces of fill material. The severed pieces can then be inserted into a container (e.g., a shipping box) as void fill or placed around an object as cushioning. One difficulty with severing the converted fill material is ensuring that the severed piece of fill material does not unintentionally fall out of the conversion machine. When severed pieces fall out of the conversion machine, a packer typically needs to spend extra time collecting the fallen piece and, in some cases, the piece is no longer usable. To address this problem, a catching device, such a bin, can be used to catch and hold severed pieces of fill material that fall out of the conversion machine. However, these catching devices can take up more space than is desirable in a packing environment and may not be ergonomical for a packer, such as if the packer must repeatedly bend down to pick up severed pieces of fill material out of the catching device. Another solution to this problem has been to provide a chute that directs falling pieces of severed fill material to the user. However, these chutes also take up space, may require the conversion machine to be moved away from the user, and do not solve the issue of intended dispensing of severed pieces of fill material.

Another solution that has been developed for some conversion machines is a conversion machine mode that is sometimes called "cut-and-hold." When using a cut-and-hold option, a conversion machine typically produces a predetermined length of fill material and then cuts the material to form a separated piece of fill material. The conversion machine then retains the piece of fill material for the packer to remove from the conversion machine. This retention is usually accomplished through friction between the piece of fill material and the conversion machine. Once the packer removes the piece of fill material from the conversion machine, the conversion machine produces another piece of fill material, cuts the material to form a new separated piece of fill material, and retains the new piece of fill material until the packer removes it from the conversion machine. However, the friction caused by the retention system has a tendency to jam the conversion machine, particularly when the conversion machine operates at high speeds (e.g., 300 feet/minute or more). Jamming of paper in the conversion machine results in down time of the conversion machine and labor costs to unjam the conversion machine. To compensate for jamming, the amount of tension or friction could be reduces on the retention system. How-

ever, with less friction and/tension during some of the hold periods, the retained piece of fill material sometimes falls out of the conversion machine (e.g., due to air flow—such as from fans—in the packer's area). When the retained piece of fill material falls out, the conversion machine produces another piece of fill material because it senses that the paper has been removed. This results in some of the same issues described above. Not only are the same issues present, but the cost and complexity of the conversion machine have risen due to the need for the retention system that holds pieces of fill material after they have been severed.

Described herein are embodiments of cutting mechanisms for conversion machines that do not fully separate two pieces of fill material but allow for a packer to manually separate the two pieces of fill material. In some embodiments, the cutting mechanism leaves a number of uncut portions across the cut ends of the two pieces of fill material. In some embodiments, the uncut portions are sufficiently small such that a packer can manually pull on one of the two pieces of cut fill material to cause the uncut portions to tear, resulting in the two pieces of cut fill material being separate from each other. In some examples, the percentage of the width of the cut fill material that is connected by all the uncut portions after the material is cut is in a range that is at least one of a range from about 1% to about 10%, a range from about 3% to about 9%, or a range from about 5% to about 8%. In some examples, the percentage of the width of the cut fill material that is connected by one of the uncut portions after the material is cut is less than or equal to any one of 1%, 0.8%, 0.6%, 0.4%, or 0.2%. In some embodiments, the uncut portions are capable of maintain the two pieces connected until one of the pieces is pulled away from the other (e.g., pulled away by a packer). One benefit of the amount of fill material that remains uncut being relatively small is that the packer typically does not need to exert much force to tear the uncut portions as the packer pulls the two pieces apart. In some cases, the packer is unable to distinguish any difference in the amount of force required to pull out a piece of fill material from a cut-and-hold conversion machine (e.g., in existing conversion machines) and the amount of force required to tear the uncut portions of the paper that remain when using the cutting mechanisms in the embodiments described herein.

Depicted in FIG. **2** is an embodiment of a cutting mechanism **140** in the conversion machine **110**. In some embodiments, the cutting mechanism **140** includes a cutting surface **142** and a cutting surface **144**. In some embodiments, at least one of the cutting surfaces **142** and **144** is configured to move with respect to the other to cut portions of the fill material **130**. The cutting mechanism **140** is also configured such that, when the cutting mechanism **140** cuts the void fill material **130**, the fill material **130** leaves a number of uncut portions across the cut ends of the fill material **130**.

In the depicted embodiment, the cutting surface **142** in the cutting mechanism **140** is a notched blade that has a notch **146** in the cutting surface **142**. As can be seen in FIG. **2**, the conversion machine **110** is configured to fold or crumple the sheet material **120** to form the fill material **130** so that multiple plies of the fill material **130** are located between the two cutting surfaces **142** and **144**. The notch **146** is located on the cutting surface **142** so that multiple plies of the fill material **130** are aligned with the notch **146**. In some embodiments, the length of the notch **146** is a percentage of the length of the cutting surface **142** that is less than or equal to any one of 10%, 9%, 8%, 7%, 6%, 5%, 4%, 3%, 2%, or 1%.

In other embodiments, such as shown in FIG. **5**, the cutting mechanism **140** can have a single cutting surface **151**. In those embodiments, the fill material **130** can be located between the single cutting surface **151** and a slot **155**, and the single cutting surface **151** can move into the slot **155** as the single cutting surface **151** cuts the fill material **130**. In those embodiments, the single cutting surface **151** can include a notch **153** that is aligned with the uncut portions of the fill material **130** when the single cutting surface **151** cuts the fill material **130**. In other embodiments, such as shown in FIG. **6**, the cutting mechanism **140** can have at least two cutting surfaces **161**. In those embodiments, the fill material **130** can be located between the at least two cutting surfaces **161** and a slot **165**, and the at least two cutting surfaces **161** can move into the slot **165** as the at least two cutting surfaces **161** cut the fill material **130**. In those embodiments, the at least two cutting surfaces **161** can be separated by a gap **163** and the gap **163** is aligned with the uncut portions of the fill material **130** when the at least two cutting surfaces **161** cut the fill material **130**.

At the instance depicted in FIG. **2**, a leading end **152** of the fill material **130** is at the cutting surfaces **142** and **144** where it was previously cut by the cutting surfaces **142** and **144** from a now-separated piece of the fill material **130**. The leading end **152** includes tabs **154**. The tabs **154** are substantially aligned with the notch **146**, indicating that the tabs **154** were the uncut portions of the fill material when the cutting surfaces **142** and **144** cut the fill material **130** before the now-separated piece of the fill material **130** was removed. The tabs **154** remained on the leading end **152** when the now-separated piece of the fill material **130** was removed (e.g., pulled away by a packer). In any of the embodiments described herein, a notch in a cutting surface or a gap between cutting surfaces can have a length that is in a range between about 0.01 inches and about 0.25 inches, in a range between about 0.05 inches and about 0.2 inches, or in a range between about 0.1 inches and about 0.15 inches.

From the position shown in FIG. **2**, the conversion machine **110** can advance the fill material **130** to the position shown in FIG. **1**. At the position shown in FIG. **1**, the leading end **152** of the fill material **130** is out away from the conversion machine **110**. At that point, the cutting mechanism **140** inside of the conversion machine **110** can cut the fill material **130**. Depicted in FIG. **3** is an embodiment of two pieces **150** and **160** of the fill material **130** after the cut is made in the fill material **130** when the fill material is in the position shown in FIG. **1** and before the two pieces **150** and **160** of cut fill material **130** have been separated.

As can be seen in FIG. **3**, the cutting mechanism **140** cut through multiple folded or crumpled plies of the fill material **130** to form a trailing end **156** in the piece **150** of the fill material **130** and a leading end **162** in the piece **160** of the fill material **130**. The notch **146** of the cutting surface **142** left a number of uncut portions **132** (though only one is visible in FIG. **3**) across the cut trailing end **156** and leading end **162** of the two pieces **150** and **160** of the fill material **130**. With the uncut portions **132** of the fill material **130** in place, the two pieces **150** and **160** of the fill material **130** remain connected to each other. This keeps the piece **150** connected to the piece **160** until the piece **150** is pulled from the piece **160**. Thus, when the piece **160** is part of the fill material **130** inside the conversion machine **110**, the conversion machine continues to hold the piece **150** on the end of the piece **160** until the piece **150** is pulled away from the piece **160**.

Depicted in FIG. **4** is a n example of the piece **160** of the fill material **130** after the two pieces **150** and **160** of the fill material **130** have been separated from each other. In some embodiments, the piece **150** was separated from the piece **160** by a person (e.g., a packer) pulling the piece **150**, which caused the uncut portions **132** between the two pieces **150** and **160** to tear. In the depicted embodiment, most of the uncut portions **132** tore on the side of the uncut portions **132** closer to the piece **150** such that the uncut portions **132** became tabs **164** on the leading end **162** of the piece **160** when the piece **150** was pulled away from the piece **160**.

As described above, a piece of fill material can be created by a process that includes advancing the fill material **130** by the conversion machine **110**, cutting the fill material **130** by a cutting mechanism **140** that leaves uncut portions between two pieces, and pulling the piece away from the fill material **130** by a person to tear the uncut portions. The piece of the fill material **130** is then separated and can be used as fill. In some embodiments, the conversion machine **110** can detect that the piece has been torn away and then automatically advance the fill material **130** and cut the material **130** so that uncut portions remain. This process can be repeated as many times as the person continues to pull pieces away from the fill material **130**.

Some of the benefits of the embodiments described herein over existing conversion machines include reduced complexity, lower cost, and greater reliability. With cut-and-hold systems, not only do those systems have a severing mechanism but also a tension holding mechanism. In contrast, the embodiments disclosed herein include a cutting mechanism that leaves uncut portions of the fill material after a cut instead of having both a severing mechanism and a tension holding mechanism. This not only reduces cost because of the reduced number of parts, but also reduces the complexity of the conversion machine because the fill material holds the cut piece instead of a tension mechanism in the conversion machine holding the cut piece. In addition, the issue of inadvertent falling of fill pieces in existing system is addressed by the embodiments described herein because the uncut portions prevent a cut piece of fill from falling from the force of gravity alone. This increases the reliability of the embodiments disclosed herein over existing conversion machines.

For purposes of this disclosure, terminology such as "upper," "lower," "vertical," "horizontal," "inwardly," "outwardly," "inner," "outer," "front," "rear," and the like, should be construed as descriptive and not limiting the scope of the claimed subject matter. Further, the use of "including," "comprising," or "having" and variations thereof herein is meant to encompass the items listed thereafter and equivalents thereof as well as additional items. Unless limited otherwise, the terms "connected," "coupled," and "mounted" and variations thereof herein are used broadly and encompass direct and indirect connections, couplings, and mountings. Unless stated otherwise, the terms "substantially," "approximately," and the like are used to mean within 5% of a target value.

The principles, representative embodiments, and modes of operation of the present disclosure have been described in the foregoing description. However, aspects of the present disclosure which are intended to be protected are not to be construed as limited to the particular embodiments disclosed. Further, the embodiments described herein are to be regarded as illustrative rather than restrictive. It will be appreciated that variations and changes may be made by others, and equivalents employed, without departing from the spirit of the present disclosure. Accordingly, it is expressly intended that all such variations, changes, and equivalents fall within the spirit and scope of the present disclosure, as claimed.

What is claimed is:

1. A system comprising:

a source of sheet material; and

a conversion machine configured to receive the sheet material and to form the sheet material into a fill material, wherein the conversion machine further comprises:

a cutting mechanism configured to cut the fill material, the cutting mechanism having a linear cutting blade having only one notch or gap in the linear cutting blade, wherein the cutting mechanism is configured such that, when cutting the fill material to form two pieces of fill material, wherein the linear cutting blade is arranged so that the notch or gap leaves a plurality of uncut portions in the fill material between the two pieces of fill material.

2. The system of claim **1**, wherein the uncut portions are arranged such that, when one of the two pieces of the fill material is pulled away from each other, the uncut portions tear, resulting in the two pieces of the fill material being separated from each other.

3. The system of claim **1**, wherein a percentage of a width of the fill material that remains connected by the uncut portions is in a range between about 1% and about 10%.

4. The system of claim **1**, wherein a percentage of a width of the fill material that remains connected by the uncut portions is in a range between about 3% and about 9%.

5. The system of claim **1**, wherein a percentage of a width of the fill material that remains connected by the uncut portions is in a range between about 5% and about 8%.

6. The system of claim **1**, wherein a percentage of a width of the fill material that remains connected by each of the uncut portions is less than or equal to any one of 1%, 0.8%, 0.6%, 0.4%, or 0.2%.

7. The system of claim **1**, wherein the cutting mechanism includes a first cutting surface and a second cutting surface, wherein the first cutting surface includes the linear cutting blade, and wherein at least one of the first and second cutting surfaces is configured to move with respect to the other of the first and second cutting surfaces to cut portions of the fill material.

8. The system of claim **7**, wherein the linear cutting blade is a notched blade that includes the notch.

9. The system of claim **8**, wherein a length of the notch is a percentage of a length of the first cutting surface that is less than or equal to or any one of 10%, 9%, 8%, 7%, 6%, 5%, 4%, 3%, 2%, or 1%.

10. The system of claim **7**, wherein the fill conversion machine is configured to fold or crumple the sheet material to form the fill material.

11. The system of claim **8**, wherein, after the sheet material is folded or crumpled to form the fill material, multiple plies of the fill material are arranged to be cut by the cutting mechanism.

12. The system of claim **1**, wherein the linear cutting blade includes a single cutting surface that includes the notch.

13. The system of claim **12**, wherein the single cutting surface is configured to move into a slot as the single cutting surface cuts the fill material.

14. The system of claim **1**, wherein the linear cutting blade includes at least two separate cutting surfaces that are

separated by the gap, and wherein the uncut portions of the fill material are aligned with the gap as the linear cutting blade cuts the fill material.

15. The system of claim **14**, wherein the at least two separate cutting surfaces is configured to move into a slot as the at least two separate cutting surfaces cut the fill material.

16. The system of claim **14**, wherein the gap has a length that is in a range between about 0.1 inches and about 0.15 inches.

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